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A NEW MOUNTAIN MIDGE FROM CALIFORNIA (Diptera: Deuterophlebiidae)

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The peculiar nematoceros Diptera known as "mountain midges" have excited the interest and curiosity of biologists whenever they have been found. This has by no means been a common occurrence, as evidenced by the fact that the first adults were not known until 1922, when Edwards described the male of *Deuterophlebia mirabilis* from Kashmir at an elevation of 11,000-12,000 feet in some of the highest mountains of the world. In 1924 Pulkovsky described the first known larvae, pupae, and females of an unnamed species from the Altai Mountains in Siberia. Muttkowski (1927) figured a larva from Yellowstone National Park, Wyoming, which probably belongs to a species, *D. coloradensis*, described by Pennak in 1945 from Colorado. Brodsky (1930) described the larva, pupa, and female of *D. mirabilis* from Central Asia. The Japanese species, *D. nipponica*, was first reported by Kitakami in 1929, by Kawamura in 1932, and Yie in 1933, but was not named and fully described until 1938, when Kitakami gave it what is still the most complete study for any known species, based on many specimens of all stages. The same author (*ibid.*) described the larva and pupa of a second species, *D. tyosenensis*, from northern Korea. Pennak (*ibid.*) has very ably summarized the existing knowledge of the family, including references to the collecting of larvae of undetermined species in Convict Creek, Mono Co., California, and Rock Creek, Benton Co., Oregon. Stone (1949) noted the collection of a male pupa of *D. coloradensis* from Peoria Slough, Oregon, but, as will be shown later, his record probably refers to the new species here described. Thus, up to the present time only four species of *Deuterophlebia* have been named, two of which are known from the immature stages only.

During the summer of 1948 the writer had the opportunity to search for deuterophlebiids over a wide area of northern and coastal

California. His hunt was finally rewarded in the mountains near Mount Shasta in the headwaters of the Sacramento River, when he collected large numbers of larvae and pupae in a small rapid mountain stream. After finding the immature stages several hours before dusk, he made a rapid search for adults in the vicinity, but without success, owing partly to lack of time, which also precluded further visits. However, the dissection of male and female imagoes from mature pupae makes possible the description of all stages of this species, and original observations on the biology, although limited, supplement existing knowledge.

NOTES ON THE HABITS OF THE LARVAE. The larvae were collected in Fawn Creek, near its junction with the South Fork of the Sacramento River at about 5,000 feet elevation, about 10 miles southwest of Mount Shasta City, California. The stream is a typical cold mountain creek, several feet wide with riffles several inches deep, cascading over boulders and stones at a 45° slope from the last pockets of melting snow on the slopes 2,000 feet above.

The deutero-phlebiid larvae and pupae were found on the upper surface of smooth rocks, where they seemed to prefer the water line or the splash at riffle areas. They were also found on broad, fairly flat rocks covered with a thin film of very swift water. The larvae spent much time moving the head and anterior portion of the body in an arc from side to side, presumably feeding on particles they scraped off the surface of the rock. Locomotion was in a characteristic zig-zag lateral course, made possible by alternate loosening of anterior and posterior ends of the body, rotating the free end in an arc to the side, and re-attaching. A similar method for blepharicerid larvae has been described by Kellogg (1903). When the larvae are disturbed, locomotion may be surprisingly rapid, especially considering the amount of co-ordination necessary to move several sets of legs at one time, and the hazard of being swept away in the swift current.

The exceedingly simple mechanism of hooks and sucker of the larval prolegs was described and illustrated by Pulikovsky. In looking at her figures, however, the writer has reached a different conclusion regarding the function of this mechanism. It seems that the primary force for secure attachment or adhesion is not the suction of the pad at the end of the leg, but rather the simultaneous traction of the hundreds of minute retrorse hooks on each leg, which is greatest when the leg is relaxed and extended. The primary muscles

of the leg, which are attached at the center of the pad at the end of the leg, would then act by their contraction to invaginate the rows of hooks, the distal rows first, thus shortening the leg and releasing its hold on the substrate preparatory to movement.

Owing to the scarcity of males and male pupae, Kitakami postulates that *D. nipponica* may reproduce by parthenogenesis. The collection of about equal numbers of pupae of both sexes in the California material would indicate normal reproduction. The seasonal distribution of the present species is not known, but the collection of about equal numbers of larvae of all sizes indicates the existence of no marked broods, at least in mid-summer. There are four larval instars, according to Kitakami.

The deutero-phlebiids were closely associated with several other dipterous larvae and pupae of similar body form and similar habit. Individuals of undetermined species of two genera of Blephariceridae, *Agathon* and *Philorus*, were numerous, usually in deeper water than the *Deuterophlebia*. The psychodid genus *Maruina* was represented in greater abundance, and usually in shallower water or closer to the water line or upper splash line.

The discovery of this colony of *Deuterophlebia* coincided with the adoption of, and can be almost wholly credited to, the use of an apparently crude but nevertheless amazingly effective collecting method, described by Fritz Müller in 1895 for collecting *Maruina* larvae. One need only to pass his fingers, palms down, slowly and with moderate pressure over the rocks where larvae may be suspected of breeding. They are dislodged from the rocks and cling tightly to the skin, where their presence can be readily observed at close range, their color contrasting much more greatly with the hand than with the rocks of their natural habitat. The larvae can then be removed rapidly from the hand by knife or forceps, perhaps in the relative safety and comfort of a nearby boulder rather than at the brink or in the spray of a dangerous stream. More important, hundreds of samples can be taken in the time in which only one would have been possible by conventional screens, seines, or even by direct visual examination of the rocks.

Deuterophlebia shasta Wirth, new species

MALE: Length, undetermined; wing, 3.6 mm. by 1.7 mm. *Head* (fig. 1b) hidden under projecting mesonotum, small, transverse and flat. Eyes small, subspherical, without pubescence, diameter about a fourth entire width of head, projecting at antero-lateral corners of head. Clypeus with small prominent setose mesal lobe. Ocelli and

mouthparts absent; mouth opening on ventral side of clypeal lobe. Ventral margin of head rather flattened. Antennae (fig. 1*d*) six-segmented, very long, proportions of segments 10:5:16:6:6:560; first two segments enlarged, the first with fine setae; second ring-like, bare; third to fifth each with a small distal tubercle on mesal side bearing five to six peg-like hyaline sensillae; distal segment evenly tapered to filiform tip, with minute capitate sensillae on mesal surface of about proximal half.

Thorax robust, apparently devoid of vestiture. Prothorax much reduced, mesonotum very convex in front, broad and dorsally flattened caudad; scutellum flat and about four times as broad as long; postscutellum very large, as broad as mesonotum; metanotum triangular, hidden under first two abdominal tergites. Pleural structure not determined. Halteres grayish hyaline, with minute pubescence, the stem slender, knob subspherical.

Wing hyaline, with fine microtrichiae; with shape and apparent venation as in figure 1*e*; only costa, subcosta, and R_1 apparently thickened; the fan-like arrangement of secondary venation due to folding of the wing in the pupal case, this first pleat-like lengthwise, the whole then alternately folded in four sections.

Legs long and slender, proportions of mid legs as in fig. 1*h*, fore and hind legs similar; coxae and trochanters setose ventrally, the trochanters apparently two-segmented; femora with a few dorsal setae; tibiae and tarsi with well-developed ventral pubescence of fine capitate hairs; tibial spurs absent; tarsal segments obliquely articulated; last segment (fig. 1*i*) with claws unequal, reduced to lanceolate pubescent lobes, the empodium a flattened disc, nearly circular, the diameter subequal to length of fifth segment, the surfaces densely set with long very fine capitate hairs.

Abdomen broad at base, tapered distad to eighth segment which is greatly reduced and only half as broad as the genitalia. Sixth and seventh segments with low lateral prominences each bearing five or six strong, scattered spines. *Genitalia* (fig. 1*j*) simple, ninth tergite bilobed, extending between the basistyles about half their length, deeply emarginate mesad, each lobe with a pair of short blunt spines; ninth sternite poorly differentiated. Basistyles tapering, mesal surface with fine setae; dististyles simple, about half as long as basistyles, slightly tapered distad, flexor surface slightly concave and set with scattered short spinose setae. Aedeagus tube-like, slightly tapered caudad, arising between bases of basistyles, the rounded tip reaching their apices; apparently with a slightly sclerotized inner protrusible penis tube.

FEMALE: In general similar to the male, with the following differences: *Head* (fig. 1*a*) smaller than in male, with antennae (fig. 1*c*) short, segments in proportion of 27:10:30:10:10:18; the four flagellar segments at apices with one, three, three, and three, peg-like hyaline sensillae respectively; distal segment also with two mesal and one distal, short setae. *Legs* (fig. 1*g*) with femora much

stouter than in male; femora and tibiae with a few minute setae on extensor surface; tarsal segments with one or two pairs of small ventral spines, the articulations very oblique, segments two to four appearing rhomboidal; segment five with claws (fig. 1*f*) strong, equal, and simple, with basal swelling, empodium lanceolate, with short setae. *Abdomen* tapering to tip, with minute pubescence; seventh segment with single lateral bristle; eighth with irregular lateral lobe with about six short strong bristles; tenth tergite bilobed. Eighth sternite with a large conical invaginated genital chamber extending forward from the gonopore in middle of hind margin; ninth sternite bilobed, tenth sternite a pair of blunt pubescent lobes with a blunt smooth tubercle on mesal side of apices.

PUPA: *Length* variable, about 2.0-2.5 mm. Broadly oval, dorsal surface (figs. 2*a*, *f*) convex, especially in head region, flattened behind, integument strongly sclerotized dark brown, with strong gran-

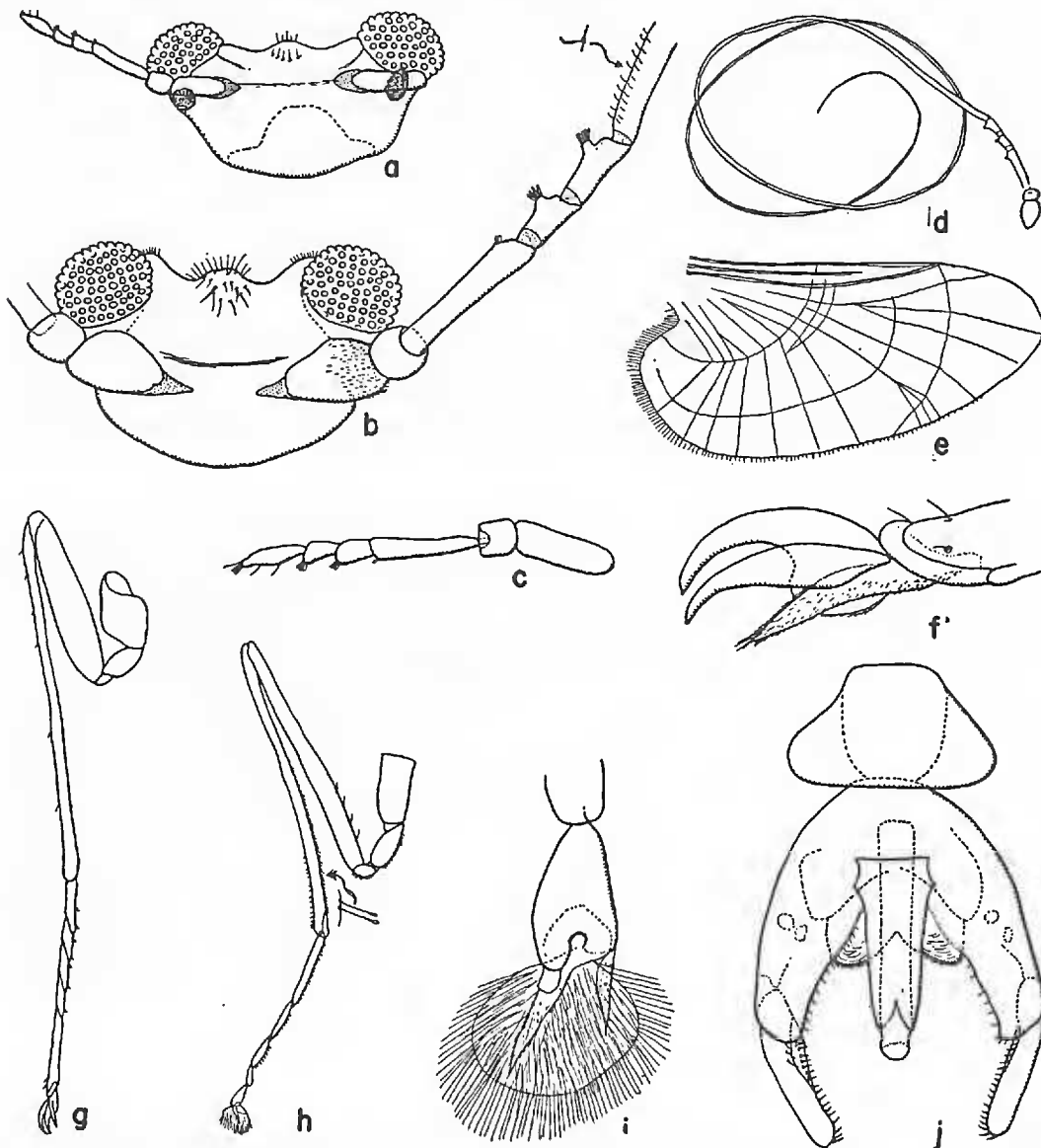


Figure 1. *Deuterophlebia shasta*. a. head, female; b. head, male; c. antenna, female; d. antenna, male; e. wing, male; f. fifth tarsal segment, female; g. mid-leg, female; h. mid-leg, male; i. fifth tarsal segment, male; j. genitalia, male, ventral aspect.

ulation especially on caudal margins of segments. Pro- and mesothorax fused, with median longitudinal seam (which splits at emergence of imago). A pair of prominent respiratory horns on anterolateral margin, each with a short thick stem and three very crooked filaments; a single long, stout spine arising from a conical tubercle dorsad of base of each respiratory organ; dorsal surface of body between these spines with a pair of long, transverse, sub-lateral lines of dark macro-granulation. Examination of the histoblasts in mature larvae shows that the respiratory organ is prothoracic, and the spine is mesothoracic. *Metanotum* small, not reaching lateral margins, with a pair of transverse lines of granulation similar to but shorter than those on mesonotum. First and second abdominal segments very narrow with ends curved forward, projecting free as very heavily sclerotized prominences with about a dozen strong black thorn-like spines. Segments three to five with undulating margins, sixth segment with five to six spines on caudo-lateral margin, mostly on ventral side; seventh segment with spinose caudo-lateral lobes bent around the small mesal eighth and ninth segments. Dorsally the male pupa distinguishable from the female by the much longer thoracic region (0.36 of the entire length in male; 0.27 in female).

Ventral surface (figs. 2*b*, *g*) flattened, not heavily sclerotized, with three pairs of blackish oval adhesive pads near lateral margins of abdominal segments three to five. Sexual dimorphism extreme on ventral aspect; male with the long antennal cases each forming two elliptical rings appressed around body; female antennal cases short, not reaching past wing cases; the latter reaching to fourth abdominal segment; leg cases reaching fifth segment in female, seventh in male.

MATURE LARVA (fig. 2*e*): Length variable, about 3.5 mm. Color yellowish-white, with some scattered orange pigment along dorsum, head and base of antennae dark brown. Body plano-convex; eleven-segmented, counting the head, the three thoracic segments, and seven leg-bearing abdominal segments; without trace of spiracles.

Head rather flat, clypeus well differentiated, with four lateral pairs of minute setae, two lateral pairs of setae well back on frons and about four pairs of multiple-branched setae near base of each antenna. Antenna arising from a short conical tubercle, proximal segment brownish sclerotized, two-thirds as long as width of head, stout, slightly tapering; bifurcating into a long dorsal and a short ventral, membranous branches, respectively about twice as long and three-fourths as long as proximal segment. A pair of small black eye-spots near lateral margin of head behind antennae.

Mouthparts (fig. 2*h*): Labrum membranous, bilobate, projecting in front of, and curving down below clypeus to ventral surface of head, with a pair of densely setose ridges curving from lateral corners in front to near mid-line on caudo-ventral margin of labrum; sides of labrum with series of short, plate-like setae. Mandibles with a heavily sclerotized ring, bearing a narrow transverse comb of brown setae, and a dense tuft of long brown hairs on caudo-mesal

margin. Maxillae a transverse lobe with a comb-like row of dense short setae, a small palpus on caudal margin near lateral ends and a small black granular spot on caudal margin near mid-line. Labium apparently a submedian pair of sclerotized flaps.

Thorax with three well-marked segments, the mesothorax broadest and most highly pigmented.

Abdomen broadest at segment four, each of the seven preapical segments with a well developed lateral pseudopod or proleg, each bearing a distal series of eight to eleven rows of small dense black hooks (fig. 2c). Front and hind margins of prolegs with dense vestiture of long, multiple-branched black hairs. Each segment dorsally with a few fine setae in a transverse row. Eighth segment consisting of a pair of tapering curved lobes, bearing a pair of black peg-like spines and a hair at apex (fig. 2d); on ventral side with five white, sausage-shaped, anal gills.

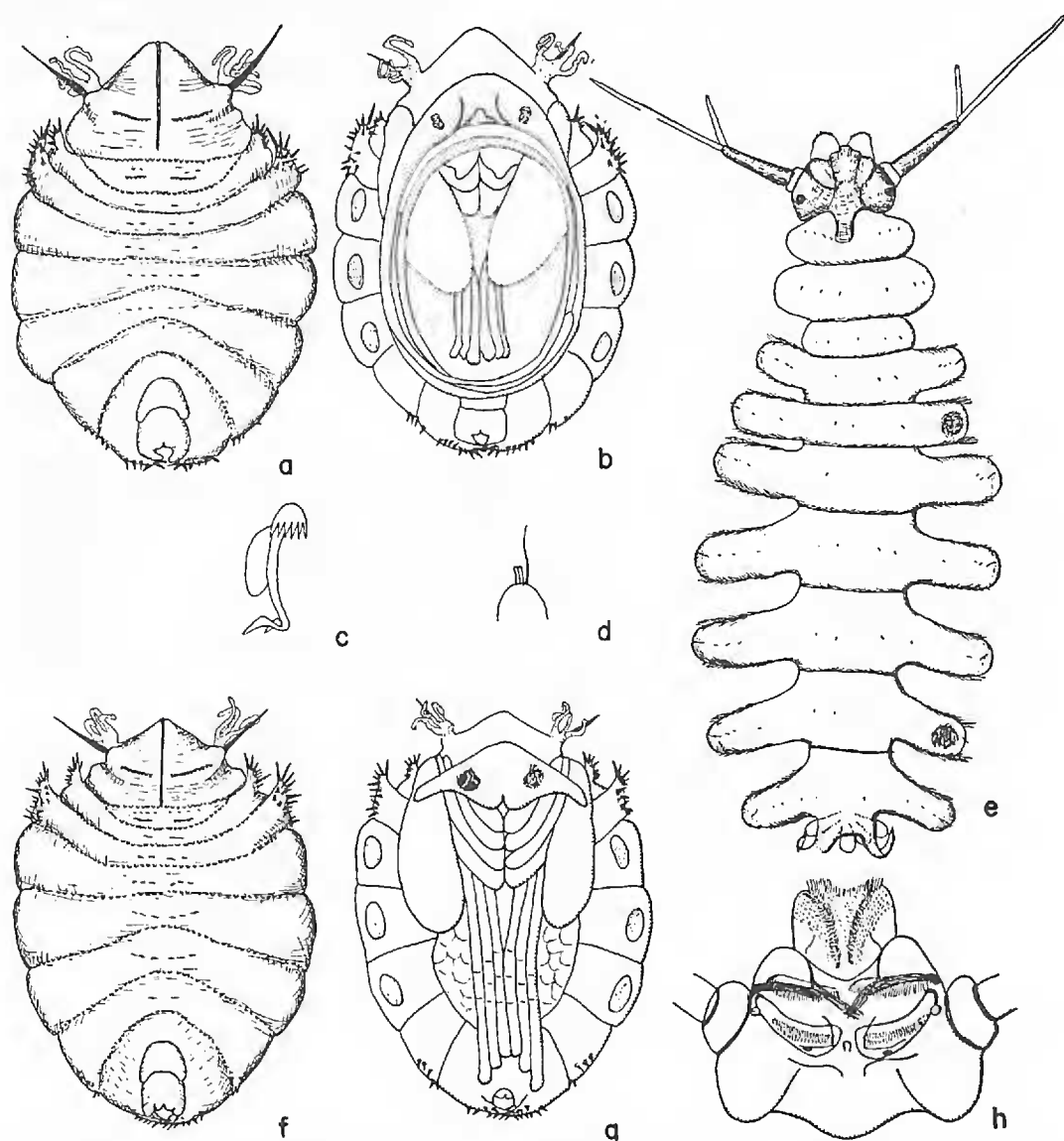


Figure 2. *Deuterophlebia shasta*. a. male pupa, dorsal view; b. same, ventral; c. detail of hook of larval proleg; d. detail of tip of eighth abdominal segment of larva; e. mature larva, dorsal view (hooks of second and sixth prolegs, right side, inverted); f. female pupa, dorsal view; g. same, ventral; h. larval head, ventral view showing mouth parts.

Holotype male, dissected from pupa, FAWN CREEK, near headwaters of South Fork, Sacramento River, SISKIYOU COUNTY, CALIFORNIA, July 22, 1948, W. W. Wirth. (TYPE No. 59,374, U. S. National Museum) *allotype* female; *paratypes* 2 males, 1 female dissected from pupae; 25 pupae and 100 larvae in various stages, same data as type. Adult paratypes will be deposited in the California Academy of Sciences and the British Museum of Natural History.

COMPARATIVE NOTES. The species of *Deuterophlebia* are difficult to separate in the larval and adult stages because of poorly diagnostic characters. However, the pupae are quite distinctive and Pennak has given a key to separate them. *D. shasta* falls in couplet two of Pennak's key with Pulikovsky's Altai Mountain species on the basis of the single long thoracic spine near the respiratory organ. From her species it may be separated as follows:

Pupa with distinct transverse granulose lines on dorsum of thoracic segments; larvae yellowish to light orange in color; adult female antenna with two pre-apical setae on last segment.....*shasta*
 Pupa without differentiated lines on dorsum of thorax; larvae dark brown on dorsal surface; adult female antenna with at least five pre-apical setae on last segment..... (Pulikovsky's species)

The pupa reported by Stone (1949) from Oregon as *D. coloradensis* is in the U. S. National Museum collection and has been examined by the writer. It possesses the single pair of thoracic spines. The range of *shasta* doubtless extends over a much wider area along the Pacific Coast while that of *coloradensis* remains within the Rocky Mountain system so far as known.

The writer wishes to thank Dr. R. W. Pennak of the University of Colorado for the gift of larvae and pupae of *D. coloradensis*. Pupae of the two Japanese species in the National Museum collection were also studied.

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HABITATS OF SPECIES OF NOVELSIS

(Coleoptera: Dermestidae)

Mature larvae of *Novelsis horni* (Jayne) were taken on Dec. 27, 1950, one by the writer from a *Sceliphron* nest 5 miles north of Tucson, Arizona, and one by C. B. Beal from a Leptochiline-like nest in the sandy bank of the Santa Cruz River 9 miles south of Tucson. A single mature larva of *Novelsis varicolor* (Jayne) was found by the writer in a *Sceliphron* nest 11 miles northeast of Tucson on December 28. All the larvae were reared to adults on pollen in a temperature cabinet at 31° C.—R. S. BEAL, JR.